

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 00/00171

A. CLASSIFICATION OF SUBJECT MATTER					
Int Cl ⁷ : AO1G 23/08, 23/093, B27L 11/00					
According to International Patent Classification (IPC) or to both national classification and IPC					
B. FIELDS SEARCHED					
Minimum documentation searched (classification system followed by classification symbols) IPC AO1G 23/08, 23/093, B27L 11/00					
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched AU : IPC as above					
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) DWPI + keywords					
C. DOCUMENTS CONSIDERED TO BE RELEVANT					
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.			
X	US 4 338 985 A (SMITH) 13 July 1982 whole document	1, 10			
X	US 4 784 195 A (EGGEN) 15 November 1988 whole document	1			
X	US 4 057 192 A (SMITH) 8 November 1977 whole document	1			
<input type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex					
<p>* Special categories of cited documents:</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 40%; vertical-align: top;"> <p>"A" Document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </td> <td style="width: 10%; vertical-align: top; text-align: center;"> <p>"T"</p> <p>"X"</p> <p>"Y"</p> <p>"&"</p> </td> <td style="width: 50%; vertical-align: top;"> <p>later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>document member of the same patent family</p> </td> </tr> </table>			<p>"A" Document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>	<p>"T"</p> <p>"X"</p> <p>"Y"</p> <p>"&"</p>	<p>later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>document member of the same patent family</p>
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Date of the actual completion of the international search 31 March 2000		Date of mailing of the international search report 17 APR 2000			
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200 WODEN ACT 2606 AUSTRALIA E-mail address: pct@ipaaustralia.gov.au Facsimile No.: (02) 6285 3929		Authorized officer B. NGUYEN Telephone No.: (02) 6283 2306			

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU 00/00171

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member	
US	4338985	BR	8006626
		CA	1163174
		CA	1176543
		CA	1178873
US	4784195	NONE	
US	4057192	NONE	

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NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Assistant Commissioner for Patents
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in its capacity as elected Office

Date of mailing (day/month/year) 18 October 2000 (18.10.00)	
International application No. PCT/AU00/00171	Applicant's or agent's file reference
International filing date (day/month/year) 10 March 2000 (10.03.00)	Priority date (day/month/year) 10 March 1999 (10.03.99)
Applicant GILES, Richard, Courthope et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:
28 September 2000 (28.09.00)

☐ in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was
☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer R. E. Stoffel
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION **REPORT** PCT

(PCT Article 36 and Rule 70)

REC'D 29 DEC 2000

3

Applicant's or agent's file reference AMP:AB:FP12498	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416).	
International Application No. PCT/AU00/00171	International Filing Date (day/month/year) 10 March 2000	Priority Date (day/month/year) 10 March 1999
International Patent Classification (IPC) or national classification and IPC Int. Cl. ⁷ A01G 23/08, 23/093, B27L 11/00		
Applicant OIL MALLEE COMPANY OF AUSTRALIA PTY LTD et al		

- This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
- This REPORT consists of a total of 3 sheets, including this cover sheet.
☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 5 sheet(s).

3. This report contains indications relating to the following items:

- | | | |
|------|-------------------------------------|---|
| I | <input checked="" type="checkbox"/> | Basis of the report |
| II | <input type="checkbox"/> | Priority |
| III | <input type="checkbox"/> | Non-establishment of opinion with regard to novelty, inventive step and industrial applicability |
| IV | <input type="checkbox"/> | Lack of unity of invention |
| V | <input checked="" type="checkbox"/> | Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement |
| VI | <input type="checkbox"/> | Certain documents cited |
| VII | <input type="checkbox"/> | Certain defects in the international application |
| VIII | <input type="checkbox"/> | Certain observations on the international application |

Date of submission of the demand 28 September 2000	Date of completion of the report 12 December 2000
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustalia.gov.au Facsimile No. (02) 6285 3929	Authorized Officer B. NGUYEN Telephone No. (02) 6283 2306

I. Basis of the report**1. With regard to the elements of the international application:***

- ☐ the international application as originally filed.
- ☒ the description, pages 1, 4-11, as originally filed,
pages , filed with the demand,
pages 2, 3 , received on 1 December 2000 with the letter of 1 December 2000
- ☒ the claims, pages , as originally filed,
pages , as amended (together with any statement) under Article 19,
pages , filed with the demand,
pages 12-14, received on 1 December 2000 with the letter of 1 December 2000
- ☒ the drawings, fig. 1-14, as originally filed,
pages , filed with the demand,
pages , received on with the letter of
- ☐ the sequence listing part of the description:
pages , as originally filed
pages , filed with the demand
pages , received on with the letter of

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, was on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/fig.

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**1. Statement**

Novelty (N)	Claims 1-15	YES
	Claims	NO
Inventive step (IS)	Claims 1-15	YES
	Claims	NO
Industrial applicability (IA)	Claims 1-15	YES
	Claims	NO

2. Citations and explanations (Rule 70.7)

The invention relates to an apparatus for tree harvesting, including a rotary saw, transport means for gripping a tree cut by the saw and transporting the tree to and dropping said cut tree in a chipping means, said chipping means being provided with a rotary chipping drum and a controllably moveable anvil adjacent the chipping drum.

With regard to the claims the nearest prior art document US 4338985 does not have a controllably moveable anvil. The anvil (454) in the prior art is fixed to the housing (452) and the angle of incidence between the anvil (454) and the chipper (446) cannot be varied.

The tree harvesting apparatus as claimed in claims 1-15 differs from all relevant documents and is therefore novel.

The invention is not obvious and is therefore considered to involve an inventive step.

The invention is also industrially applicable.

fast enough to harvest a practical amount per hour and harvest costs per tonne are high.

BRIEF SUMMARY OF THE INVENTION

According to the present invention there is provided a tree harvesting apparatus adapted

5 for mounting on a vehicle to effect continuous tree harvesting, said apparatus including:

a rotary saw for cutting a tree near ground level;

transport means adjacent said saw for gripping a tree cut by the saw and
transporting the tree to and dropping said cut tree in a chipping means
located at an end of the transport means distant the rotary saw for chipping
10 the tree;

whereby, in use, when said tree harvesting apparatus is mounted on the
vehicle and said vehicle driven along a row of trees, said apparatus can
continuously cut and chip said trees.

15 If the above apparatus is used in relation to Mallee trees, the chipped trees can then be
passed through a winnowing machine to separate the leaves from the chipped wood. Oil
can then be extracted from the leaves using processes that do not form part of this
invention.

20 Preferably said saw is rotated in a direction to urge said cut tree into said transport means.

Preferably the transport means transports said cut tree in a substantially upright orientation
along and inclined path to said chipping means.

25 Preferably the inclined path extends to one side of the vehicle to which said apparatus is
mounted so that said cut trees do not substantially block the line of sight of a driver of the
vehicle.

Preferably said rotary saw is a rotary circular saw and is disposed in an inclined plane so
30 that a leading edge of the saw is near ground level and below a trailing edge of the saw.

Preferably said rotary circular saw has a dished or convexly curved bottom surface for

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reducing possible contact area between the bottom surface of the saw and the ground.

Preferably said transport means includes first and second opposed conveyor means each provided with laterally extending fingers so that a cut tree is gripped by the fingers of the
5 opposed conveyor means.

Preferably said first conveyor means comprises a first endless loop chain from which a plurality of said fingers extend, and said second conveyor means comprises second and third endless chains from each of which a plurality of said fingers extend, said second and
10 third endless chains vertically spaced from each other and wherein the first endless chain is located vertically intermediate said second and third endless chains.

Preferably said second conveyor means is coupled to a floating frame that allows said second conveyor means to move relative to said first conveyor means.

15 Preferably said floating frame is arranged to allow said second conveyor means to fish tail.

Preferably said floating frame is further arranged to allow lateral sliding motion of said second conveyor means relative to said first conveyor means.

20 Preferably said chipping means is provided with a rotary chipping drum and a controllably moveable anvil adjacent said chipping drum for directing a cut tree entering said chipping means onto said chipping drum, whereby, in use, the position of the anvil can be varied to vary the angle of incidence of the tree onto the chipping drum.

25 Preferably said apparatus further includes height adjusting means for adjusting the height of said saw above the preferred level.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

30 An embodiment of the present invention will now be described by way of example only with reference to the accompanying figures in which:

CLAIMS

1. A tree harvesting apparatus adapted for mounting on a vehicle to effect continuous tree harvesting, said apparatus including:
- 5 a rotary saw for cutting a tree near ground level;
transport means adjacent said saw for gripping a tree cut by the saw and transporting the tree to and dropping said cut tree in a chipping means located at an end of the transport means distant the rotary saw for chipping the tree;
- 10 whereby, in use, when said tree harvesting apparatus is mounted on the vehicle and said vehicle driven along a row of trees, said apparatus can continuously cut and chip said trees.
2. A tree harvesting apparatus according to claim 1 wherein transport means
- 15 transports said cut tree in a substantially upright orientation along and inclined path to said chipping means.
3. A tree harvesting apparatus according to claim 2 wherein said rotary saw is a rotary circular saw and is disposed in an inclined plane so that a leading edge of the saw
- 20 is near ground level and below a trailing edge of the saw.
4. A tree harvesting apparatus according to claim 3 wherein said rotary circular saw has a dished or convexly curved bottom surface for reducing possible contact area between the bottom surface of the saw and the ground.
- 25
5. A tree harvesting apparatus according to any one of claims 1-4 wherein said transport means includes first and second opposed conveyor means each provided with laterally extending fingers so that a cut tree is gripped by the fingers of the opposed conveyor means.
- 30
6. A tree harvesting apparatus according to claim 5 wherein said first conveyor means comprises a first endless loop chain from which a plurality of said fingers

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extend, and said second conveyor means comprises second and third endless chains from each of which a plurality of said fingers extend, said second and third endless chains vertically spaced from each other and wherein the first endless chain is located vertically intermediate said second and third endless chains.

5

7. A tree harvesting apparatus according to claim 6 wherein said second conveyor means is coupled to a floating frame that allows said second conveyor means to move relative to said first conveyor means.

10 8. A tree harvesting apparatus according to claim 7 wherein said floating frame is arranged to allow said second conveyor means to fish tail.

9. A tree harvesting apparatus according to claim 8 wherein said floating frame is further arranged to allow lateral sliding motion of said second conveyor means
15 relative to said first conveyor means.

10. A tree harvesting apparatus according to any one of claims 1-9 wherein said chipping means is provided with a rotary chipping drum and a controllably moveable anvil adjacent said chipping drum for directing a cut tree entering said chipping means
20 onto said chipping drum, whereby, in use, the position of the anvil can be varied to vary the angle of incidence of the tree onto the chipping drum.

11. A tree harvesting apparatus according to any one of claims 1-10 wherein said transport means includes a first pair of spaced apart horizontally disposed camber rotating auger rollers located at an end of the transport means nearest said chipper between
25 which said cut tree is gripped and advanced toward said chipper.

12. A tree harvesting apparatus according to claim 11 wherein said first pair of auger rollers are divergent to allow a tree to fall therebetween after the tree has been
30 advanced by said auger rollers.

13. A tree harvesting apparatus according to claims 11 or 12 wherein the

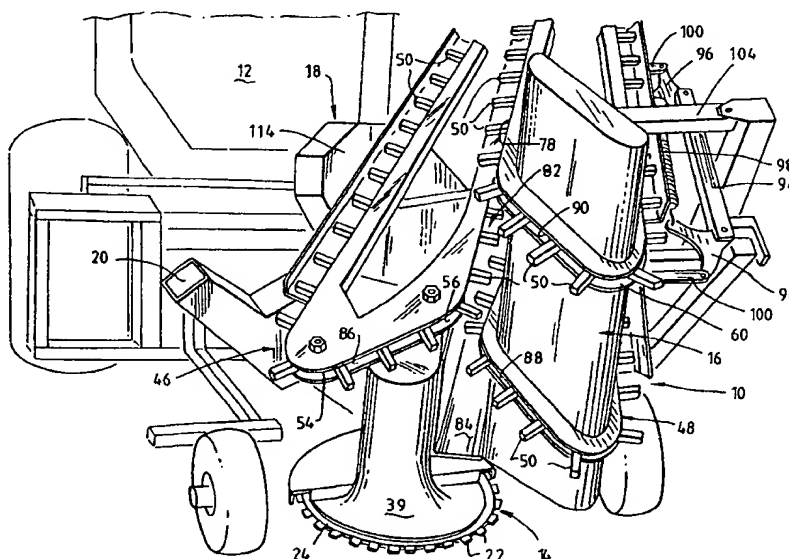
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transport means includes a second pair of spaced apart rollers inclined upwardly from a lower end distant said the chipping means for gripping a trunk of the cut tree and advancing the cut tree to said chipping means.

- 5 14. A tree harvesting apparatus according to any one of claims 1-13 further including a pair of wheels located in advance of said transport means between which a crown of a tree passes prior to the tree being cut by the rotary saw, said wheels biased and pivotally mounted to work around and at least partially compress the crown of the tree.
- 10 15. A tree harvesting apparatus substantially as herein described with reference to and as illustrated in the accompanying drawings.

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁷ : A01G 23/08, 23/093, B27L 11/00	A1	(11) International Publication Number: WO 00/52998 (43) International Publication Date: 14 September 2000 (14.09.00)
(21) International Application Number: PCT/AU00/00171 (22) International Filing Date: 10 March 2000 (10.03.00) (30) Priority Data: PP 9126 10 March 1999 (10.03.99) AU (71) Applicant (for all designated States except US): OIL MALLEE COMPANY OF AUSTRALIA PTY. LTD. [AU/AU]; 1/277 Great Eastern Highway, Belmont, W.A. 6104 (AU). (72) Inventors; and (75) Inventors/Applicants (for US only): GILES, Richard, Courthope [AU/AU]; River Road, Dwellingup, W.A. 6213 (AU). PEDERICK, Harley, Lawson [AU/AU]; 35 Vesper Street, Wagin, W.A. 6315 (AU). (74) Agent: MIZZI, Anthony, P.; Griffith Hack, 6th floor, 256 Adelaide Terrace, Perth, W.A. 6000 (AU).		(81) Designated States: AU, US, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report.</i>

(54) Title: TREE HARVESTING APPARATUS**(57) Abstract**

Tree harvester (10) is mounted on tractor (12) to enable continuously cutting and chipping of trees. The harvester (10) includes a rotary saw (14) for cutting a tree near ground level, transport means (16) adjacent the rotary saw (14) for gripping a tree cut by the rotary saw (14) and transporting the tree to and dropping the cut tree in a chipper (18) located at an end of the transport means (16) distant the rotary saw (14). The transport means (16) includes first and second opposed conveyors (46, 48) each provided with laterally extending fingers (50) so that a cut tree can be gripped by the fingers (50) of the opposed conveyors (46, 48) and subsequently transported therebetween to the chipper (18).

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EE	Estonia						

TREE HARVESTING APPARATUS

FIELD OF THE INVENTION

5 The present invention relates to a tree harvesting apparatus particularly suited for mounting on a vehicle to enable continuous tree harvesting.

BACKGROUND TO THE INVENTION

10 The present invention was initially developed to attempt to provide a cost effective way for harvesting the leaves of a mallee tree for the production of mallee oil. Manual harvesting of the leaves is possible however this is seen as not economically viable. The Applicant therefore set out to develop an apparatus or machine that, in operation, could form part of a larger process culminating in the separation of the mallee leaves from the mallee tree.

15 It is known to harvest small trees in Europe, particularly Sweden, using a modified cane harvester made by an Australian company and modified forage harvesters made by a German company. The trees harvested are about 3 metres tall and being deciduous and cut in Winter, have no leaves.

20 However, the range of mallee forms is difficult to handle with existing harvesters.

The cane harvester blocks up readily and the cutting mechanism is under the machine instead of out the front. It is designed to push the cane over before cutting and the cutting elements are five bladed discs with a very aggressive chopping action.

25

The Claas forage harvester cuts and chips out the front, but it has a lightweight agricultural chipper, it lays the trees down in front of the saws after cutting, is prone to dropping cut stems and suffers blockages with bushy forms.

30 In parts of Australia, mallees are harvested with flail cutters (a mower style, but heavily built) but the mallees are short and flexible so the harvester can pass over them before cutting without dislodging the stumps. As the mallees are small it is not possible to travel

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fast enough to harvest a practical amount per hour and harvest costs per tonne are high.

BRIEF SUMMARY OF THE INVENTION

According to the present invention there is provided a tree harvesting apparatus adapted
5 for mounting on a vehicle to effect continuous tree harvesting, said apparatus including:

a rotary saw for cutting a tree near ground level;

transport means adjacent said saw for gripping a tree cut by the saw and
transporting the tree to and dropping said cut tree in a chipping means
located at an end of the transport means distant the rotary saw for chipping
10 the tree;

whereby, in use, when said tree harvesting apparatus is mounted on the
vehicle and said vehicle driven along a row of trees, said apparatus can
continuously cut and chip said trees.

15 If the above apparatus is used in relation to Mallee trees, the chipped trees can then be
passed through a winnowing machine to separate the leaves from the chipped wood. Oil
can then be extracted from the leaves using processes that do not form part of this
invention.

20 Preferably said saw is rotated in a direction to urge said cut tree into said transport means.

Preferably the transport means transports said cut tree in a substantially upright orientation
along and inclined path to said chipping means.

25 Preferably the inclined path extends to one side of the vehicle to which said apparatus is
mounted so that said cut trees do not substantially block the line of sight of a driver of the
vehicle.

Preferably said rotary saw is a rotary circular saw and is disposed in an inclined plane so
30 that a leading edge of the saw is near ground level and below a trailing edge of the saw.

Preferably said rotary circular saw has a dished or convexly curved bottom surface for

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reducing possible contact area between the bottom surface of the saw and the ground.

Preferably said transport means includes first and second opposed conveyor means each provided with laterally extending fingers so that a cut tree is gripped by the fingers of the
5 opposed conveyor means.

Preferably said first conveyor means comprises a first endless loop chain from which a plurality of said fingers extend, and said second conveyor means comprises second and third endless chains from each of which a plurality of said fingers extend, said second and
10 third endless chains vertically spaced from each other and wherein the first endless chain is located vertically intermediate said second and third endless chains.

Preferably said second conveyor means is coupled to a floating frame that allows said second conveyor means to move relative to said first conveyor means.
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Preferably said floating frame is arranged to allow said second conveyor means to fish tail.

Preferably said floating frame is further arranged to allow lateral sliding motion of said second conveyor means relative to said first conveyor means.
20

Preferably said chipping means is provided with a rotary chipping drum and a controllably moveable anvil adjacent said chipping drum for directing a cut tree entering said chipping means onto said chipping drum, whereby, in use, the position of the anvil can be varied to vary the angle of incidence of the tree onto the chipping drum.
25

Preferably said apparatus further includes height adjusting means for adjusting the height of said saw above the preferred level.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

30 An embodiment of the present invention will now be described by way of example only with reference to the accompanying figures in which:

- 4 -

Figure 1 is a copy of a photograph of an embodiment of the tree harvesting apparatus mounted on a tractor;

Figure 2 is a schematic representation from the side of a rotary circular saw incorporated in the apparatus shown in Figure 1;

Figure 3 is a top view of the saw shown in Figure 2;

Figure 4 is a schematic representation in plan view of an elevator incorporated in the apparatus shown in Figure 1;

Figure 5 is a side view of the elevator shown in Figure 4;

Figure 6 is a schematic representation in plan view of a supporting frame for the elevator shown in Figures 4 and 5;

Figures 7, 8 & 9 illustrate various configurations of the frame shown in Figure 6 when the apparatus is in use;

Figure 10 is a partial schematic representation of a chipper incorporated in the apparatus when in a first configuration;

Figure 11 is a partial schematic representation of the chipper in a second configuration;

Figure 12 is a side view of the elevator shown in Figure 5 with a finger wheel;

Figure 13 is a plan view of the elevator shown in Figure 4 with finger wheels; and

Figure 14 is a plan view of the elevator shown in Figure 4 with auger rollers.

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Referring to Figure 1, a tree harvesting apparatus 10 in accordance with an embodiment of this invention is shown mounted on the front of a vehicle in the form of tractor 12. The tree harvesting apparatus 10 includes a rotary circular saw 14 for cutting a tree near ground level, a transport means 16 adjacent the saw 14 for gripping a tree cut by the saw 14 and transporting the tree to, and dropping the cut tree in, a chipping means in the form of a chipper 18 located at an end of the transport means 16 distant the rotary saw 14. The tree harvesting apparatus 10 mounted on the tractor 12 can be driven through a row of trees to effect continuous tree harvesting in which the saw 14 initially cuts the tree near ground level, the transport means 16 transports the cut tree to, and drops it in, the chipper 18 which chips the trees. Essentially the whole of the tree is chipped including branches and leaves. The chipper 18 has a chute 20 for ejecting the chips into a collection bag or bin towed or otherwise carried by the tractor 12. When the apparatus 10 is used in relation to mallee trees, the leaves can be separated from the chipped wood of the tree by conventional means such as winnowing. From there, oil can be extracted from the leaves using known processes that do not form part of this invention.

Referring to Figures 2 and 3, it can be seen that the rotary saw 14 is a circular type saw having a plurality of teeth 22 releasable attached about the periphery of a rotary disk 24. The teeth 22 are conventional replaceable teeth. The disk 24 is attached to a shaft 26 supported about its upper and lower ends by bearings 28. A pulley 30 (refer to Figure 3) is fixed to the top of the shaft 26 and is coupled by a belt 32 to a second pulley 34 which in turn is fixed to a hydraulic motor 36. The hydraulic motor 36 is plumbed into the hydraulic system of the tractor 12. The saw 14 and hydraulic motor 36 are supported on a sub-frame 38 that in turn is mounted on the tractor 12. The saw 14 and hydraulic motor 36 are supported on a sub-frame that in turn is mounted on the tractor 12. A guard 39 is provided over the disk 24 to ensure that the cut stem/trunk of the tree does not sit or bear on the disk 24. This reduces friction on the disk 24 thereby reducing power requirements.

As is most apparent from Figure 2, the saw 14, and in particular the saw disk 24, is disposed in an inclined plane so that a leading (cutting) edge 40 is nearest ground level and below trailing edge 42 of the saw 14. Additionally, the bottom of the circular saw 14, and more specifically the disk 24 has a dished or convexly curved bottom of the surface

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44. The inclining of the saw 14 and shaping of the bottom of the surface 44 is provided to reduce possible contact area between the bottom of the surface 44 and the ground. The reasons for this is to minimise the wear of the saw 14. The saw is rotated in a direction (in this embodiment anticlockwise) to urge the cut tree to the transporter 16.

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The transport means (referred to in general as "the transporter") 16 includes first and second opposed conveyor means 46, 48 (see Figure 4), each provided with laterally extending fingers 50 so that a cut tree can be gripped by the fingers 50 of the opposed conveyors 46, 48 and subsequently transported therebetween to the chipper 18.

10

The first conveyor 46 is in the form of an endless loop chain 52 from which a plurality of the fingers 50 extend. The chain 52 travels around a substantially triangular path. The triangular path is formed by two idler sprockets 54 and 56 and a drive sprocket 58 that provides the drive to cause the chain 52 to travel about the triangular path.

15

The second conveyor 48 comprises second and third endless loop chains 60 and 62 from each of which a plurality of the fingers 50 extend. The second and third endless chains 60 and 62 are vertically spaced from each other with the first chain 52 being located vertically intermediate the chains 60 and 62 as is clearly shown in Figure 5. Both the chains 60 and 62 travel in triangular paths. The path of the chain 60 is described by idler sprockets 64 and 66 and drive sprocket 68. The triangular path of chain 62 is described by idler sprockets 70 and 72 and drive sprocket 74. Each of the triangular paths of chains 52, 60 and 62 are in inclined planes.

20

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The drive sprockets 68 and 74 of the chains 60 and 62 are geared together in a 1 to 1 ratio by a transmission 76. Chain 52 is driven in an anticlockwise direction and chains 60 and 62 are driven in a clockwise direction so that the run 76 of chain 52, and adjacent runs 78 and 80 of chains 60 and 62 respectively are all moving in the direction from the saw 14 to the chipper 18. The region between the runs 76, 78 and 80 defines an inclined path 82 up along which a cut tree is transported prior to dropping into the chipper 18. A skid pan or base 84 is formed underneath the path 82 to support a base of the cut tree. The shortest run 86 of chain 52 extending between idler rollers 54 and 56 converges with the shortest

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run 88 of chain 80 extending between idler rollers 70 and 72, and the shortest run 90 of chain 78 extending between idler rollers 64 and 66 to form a throat leading into the inclined path 82.

- 5 The first conveyor 46 is mounted on a frame 90 (refer to Figures 6-9) that in turn, is mounted to the tractor 12 via sub-frame 38. The frame 90 also supports the base 84 on which the base of a cut tree can be supported while being transported up the transporter 16.
- 10 The second conveyor 48 is mounted on a floating frame 92 that in turn is supported by the tractor 12 via sub-frame 38. The floating frame 92 is able to fishtail those shown in Figures 7 and 8 and also able to slide laterally as depicted in Figure 9. To facilitate this movement, the frame 92 is coupled by a variety of links to a support beam 94 that is fixed to the sub-frame 38. A bell crank 96 is pivotally coupled at each end of the support beam
- 15 94. Adjacent arms of the respective bell cranks 96 are coupled by a spring 98. The other arm of each bell crank 96 is coupled by respective first and second arms 100 and 102 to the frame 92. The arm 100 is pivotally connected at one end to the corresponding bell crank 96 and pivotally connected at its opposite end to the adjacent arm 102. The opposite end of arm 102 is fixed to the frame 92. Between each bell crank 96, there is a further link
- 20 between the frame 92 and the support beam 94 provided by arms 104, 106 and 108. The arm 104 extends perpendicularly from bar 94 toward the frame 92 and is fixed at its end adjacent the beam 94. The opposite end of arm 104 is permanently coupled to arm 106. The opposite end of arm 106 is permanently coupled to one end of arm 108. The opposite end of arm 108 is fixed to the frame 92 and extends perpendicularly therefrom.
- 25 By virtue of this coupling, the frame 92 can fishtail relative to the frame 90 as depicted in Figures 7 and 8. Also, as depicted in Figure 9, the frame 92 can slide laterally off frame 90. This motion allows the floating frame 92 to move around a tree as it is transported along inclining path 92 toward the chipper 18.

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The chipper 18 is in the form of a drum chipper (refer to Figures 10 and 11) having a conventional rotating chipping drum 110 provided with a cutting blade 112. The drum

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110 is rotatably mounted in a chipper housing 114 which also forms the chute 20. A pair of counter rotating feed rollers 116 and 118 are provided to one side of the drum 110. A tree cut by the saw 14 and transported by the transporter 16 is dumped into the chipper 18 so that it initially passes between the counter rotating feed rollers 116 and 118 which in turn push the tree against the drum 110. The drum 110, and rollers 116 and 118 are of essentially conventional construction and form. However, the chipper 18 differs from conventional known chippers by the inclusion of a moveable anvil 120. Movement of the anvil 120 controls the angle of incidence of the cut tree to the drum 110. This variation in angle may be from close to square on (shown in Figure 10) where a tree extends almost radially from the drum 110 to near tangential (shown in Figure 11).

The anvil 120 is fixed to a pivot arm 122 that can be rotated about the rotational axis of the drum 110. A pair of telescopically related plates 124 and 126 extend from the anvil 120 to a point 128 located between rollers 116 and 118 but closest to roller 118. Plate 126 is pivoted at point 128 and plate 124 is pivoted adjacent the anvil 120. This allows the plates 124 and 126 to telescope toward and away from each other as the arm 122 is pivoted in the anti-clockwise and clockwise directions respectively. The plates 124 and 126 form a guide and support for the cut tree as it is being chipped by the chipping drum 110. When pivot arm 122 is pivoted in the clockwise direction, the plates 124 and 126 can be telescoped away from each other to the maximum extent as shown in Figure 11, so that they run approximately tangentially to drum 110 and roller 118. The angle of the pivot arm 122 and thus the position of the anvil 120 can be varied by use of a hydraulic or pneumatic ram or an electric screw jack, or any other conventional means. The ability to move the position of the anvil 120 and thus adjust angle of incidence of the tree to the chipping drum 110 enables the apparatus 10 to be used for a large variety of trees. This is because different trees have different physical characteristics which dictate the optimum instant angle for chipping. In particular reference to mallee trees, the provision of the adjustable chipper 18 enables highly efficient harvesting over the full range of mallee trees as it allows separation of all leaves from the twigs whilst minimising leaf damage and producing the largest possible wood chips. These requirements work against each other. Severe chipping breaks all leaves from the twigs but also causes more leaf damage (resulting in evaporation of oil from the leaves); produces a high proportion of very small

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wood chips (which are difficult to separate from the leaves and are not desirable for other uses); and consumes more power from the harvester and increases chipper maintenance costs.

5 A typical operating cycle of the apparatus 10 will now be described.

With the apparatus 10 mounted on a tractor 12, the tractor 12 is driven along or through a row of tree (not shown). As the apparatus 10 approaches the first tree, the saw 14 cuts the trunk off the tree near ground level. It is preferred that the cut be made as close as ground
10 level as possible but not so close so that there is contact between saw 14 and the ground. Referring to Figure 1, the saw 14 is rotated in the anti-clockwise direction so as to effectively direct the cut tree in between the first and second conveyors 46 and 48 of the transporter 16. The tree is gripped between the fingers 50 that extend from the endless chains 52, 60 and 62 and directed up the inclined path 82. The bottom of the cut tree may
15 slide along the base 84. The tree is transported in a substantially upright or vertical orientation. When it reaches the end of the inclined path 82, it is dropped into the chipper 18. The cut end of the tree is gripped by and between the rollers 116 and 118 and forced onto the drum 110. The angle of incidence of the tree onto the drum 110 can be adjusted by pivoting the arm 122 in a clockwise or anti-clockwise to raise or lower the anvil 120.
20 The tree is then wholly chipped with the chips ejected from the chute 20 into a container (not show). It is envisaged that while one tree is being chipped by the chipper 18 another is being cut by the saw 14. In this way, the tractor 12 can be driven at a continuous pace through a line of trees to sequentially and continuously cut and chip the trees.

25 A second embodiment of the apparatus 10A with improved tree handling characteristics is depicted in part in Figures 12 - 14. The tree harvesting apparatus 10 depicted in Figures 1 - 11 forms the basis of the apparatus 10A and like numbers are used to denote similar features in the apparatus 10A.

30 The apparatus 10A differs from apparatus 10 by the inclusion of a further endless loop chain 130 in the first conveyor 46; the addition of spaced apart finger wheels 132A and 132B, upper auger rollers 134A and 134B and lower auger rollers 136A and 136B.

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The endless loop chain 130 travels in a path defined by an idler roller 138 and a driven roller 140. The roller 140 is provided with a drive via a transmission 142 coupled with the drive sprocket 58. The chain 130 is in a plane parallel to and above the chains 52 (chain 60 is on the left hand side of the elevator). Fingers 50 extend laterally from the chain 130 for gripping a tree passing through the transporter 16.

The finger wheels 132A and 132B are located on opposite sides of the path 82. Each of the finger wheels is supported on a separate horizontal arm 144 that is able to pivot in a horizontal plane. The arms 144 are biased to direct the wheels 132A, 132B toward each other. The wheels 132A and 132B are also provided with radially extending fingers 146 for engaging the crown of a tree passing through the transporter 16. The wheels 132A and 132B counter-rotate and together with the bias applied to the arms 144 the wheels 132A and 132B work around the crown of a tree and actively push the tree into the transporter 16 as the saw 14 cuts the tree at the base.

The auger rollers 134A, 134B, 136A and 136B form part of the transporter 16 for transporting trees to the chipper 18. The purpose of the auger rollers is to compress the trees together into the chipper feed hopper to form a continuous stream of feed into the chipper feed rollers. The auger rollers are fixed in position above the chipper 18. Each pair counter-rotate so that they pull the trees back into a chipper feed hopper 146 and simultaneously throw the trees down toward the chipper 18.

The top pair of auger rollers 134A and 134B are disposed in a horizontal plane and act about the crown of the tree. As shown most clearly in Figure 14, the rollers 134A and 134B are divergent so that the spacing between them increases as the tree is pulled further along. Thus a point is reached which the tree is able to pass between the rollers 134A and 134B.

The bottom rollers 136A and 136B are inclined at the same angle as the conveyors 46 and 48 and pull the butt ends of cut trees out from between the conveyors 46 and 48. The speed of the augers 134, 136 is set so that their flights "travel" from front to rear at

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approximately the same speed as the chains 52, 60, 62 and 130.

Now that an embodiment of the invention has been described in detail it will be apparent to those skilled in the relevant arts that numerous modifications and variations may be made without departing from the basic inventive concepts. For example, the first conveyor 26 can be provided with multiple endless chains (similar to the conveyor 48).

Alternatively, the first conveyor 46 can be provided with two endless chains and the second conveyor 48 provided with the single endless chain. Also, although the transporter 16 is shown as configured so as to elevate the cut tree along the inclined path 82, it is possible for the transporter to transport the cut tree without causing its elevation.

However, it is preferred to elevate the tree to ensure that it does not engage the ground or any shrubs as it is being transported and also to reduce the overall size of the apparatus 10.

Also, the apparatus 10 may be provided with means for allowing adjustment of the height of the saw 14 above the ground. This can be either a manual system such as a screw jack or an automatic system using for example, optical level sensors or strain gauges to provide a feedback signal of the distance between the saw 14 and ground level to subsequently control hydraulic rams for raising and lowering the sub-frame 38 and thus the saw 14.

Additionally, the chipping drum 110 can be provided with more than a single cutting blade, with one to four blades being typical. Finally, while the preferred embodiment is described in relation to the harvesting of mallee trees, it may be used for harvesting other types of trees and bushes.

All such modifications and variations are deemed to be within the scope of the present invention, the nature of which is to be determined from the above description.

CLAIMS

1. A tree harvesting apparatus adapted for mounting on a vehicle to effect continuous tree harvesting, said apparatus including:

5 a rotary saw for cutting a tree near ground level;
transport means adjacent said saw for gripping a tree cut by the saw and transporting the tree to and dropping said cut tree in a chipping means located at an end of the transport means distant the rotary saw for chipping the tree;

10 whereby, in use, when said tree harvesting apparatus is mounted on the vehicle and said vehicle driven along a row of trees, said apparatus can continuously cut and chip said trees.

2. A tree harvesting apparatus according to claim 1 wherein transport means
15 transports said cut tree in a substantially upright orientation along and inclined path to said chipping means.

3. A tree harvesting apparatus according to claim 2 wherein said rotary saw is a rotary circular saw and is disposed in an inclined plane so that a leading edge of the saw
20 is near ground level and below a trailing edge of the saw.

4. A tree harvesting apparatus according to claim 3 wherein said rotary circular saw has a dished or convexly curved bottom surface for reducing possible contact area between the bottom surface of the saw and the ground.

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5. A tree harvesting apparatus according to any one of claims 1-4 wherein said transport means includes first and second opposed conveyor means each provided with laterally extending fingers so that a cut tree is gripped by the fingers of the opposed conveyor means.

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6. A tree harvesting apparatus according to claim 5 wherein said first conveyor means comprises a first endless loop chain from which a plurality of said fingers

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extend, and said second conveyor means comprises second and third endless chains from each of which a plurality of said fingers extend, said second and third endless chains vertically spaced from each other and wherein the first endless chain is located vertically intermediate said second and third endless chains.

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7. A tree harvesting apparatus according to claim 6 wherein said second conveyor means is coupled to a floating frame that allows said second conveyor means to move relative to said first conveyor means.

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8. A tree harvesting apparatus according to claim 7 wherein said floating frame is arranged to allow said second conveyor means to fish tail.

9. A tree harvesting apparatus according to claim 8 wherein said floating frame is further arranged to allow lateral sliding motion of said second conveyor means relative to said first conveyor means.

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10. A tree harvesting apparatus according to any one of claims 1-9 wherein said chipping means is provided with a rotary chipping drum and a controllably moveable anvil adjacent said chipping drum for directing a cut tree entering said chipping means onto said chipping drum, whereby, in use, the position of the anvil can be varied to vary the angle of incidence of the tree onto the chipping drum.

20

11. A tree harvesting apparatus according to any one of claims 1-10 wherein said transport means includes a first pair of spaced apart horizontally disposed camber rotating auger rollers located at an end of the transport means nearest said chipper between which said cut tree is gripped and advanced toward said chipper.

25

12. A tree harvesting apparatus according to claim 11 wherein said first pair of auger rollers are divergent to allow a tree to fall therebetween after the tree has been advanced by said auger rollers.

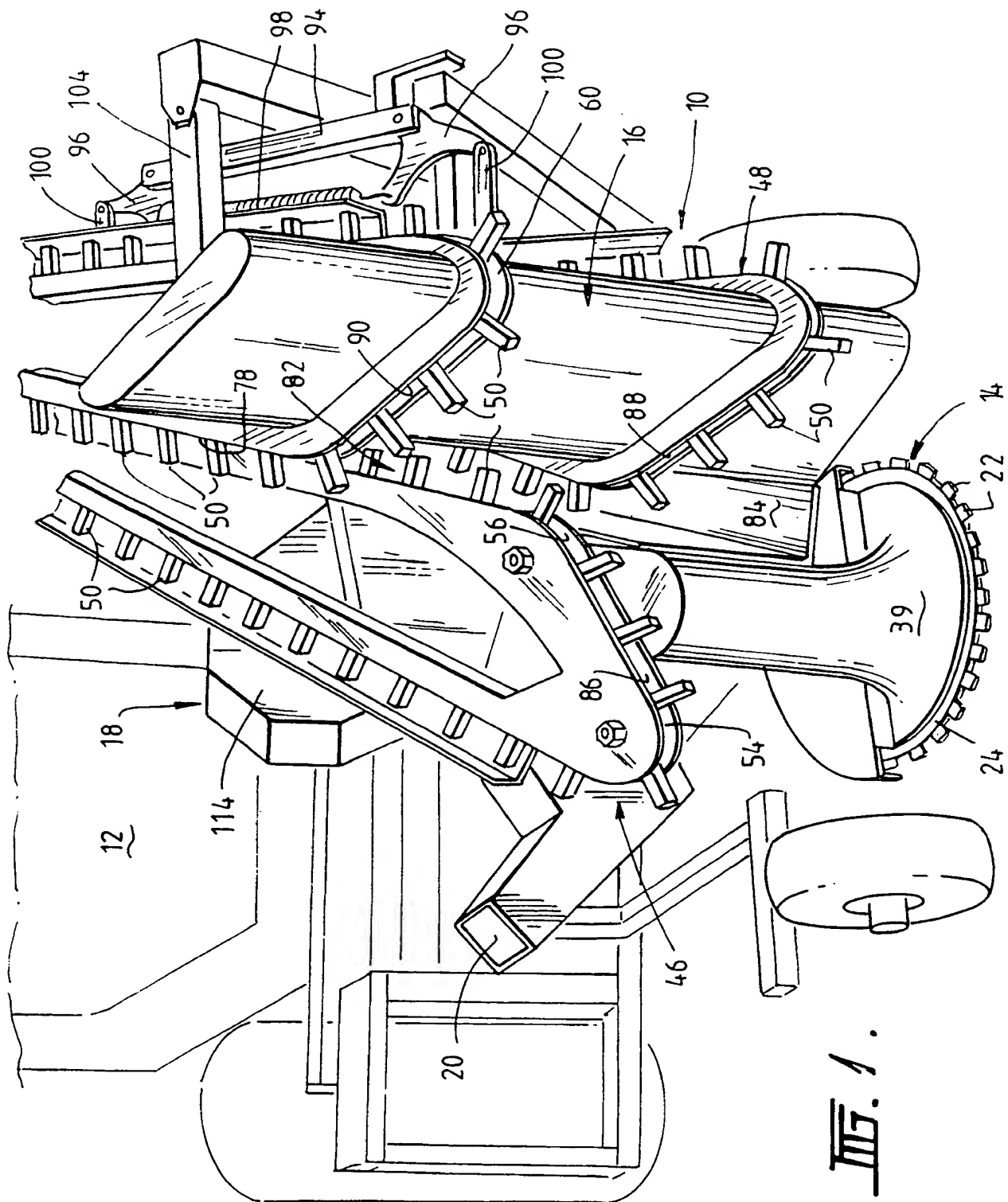
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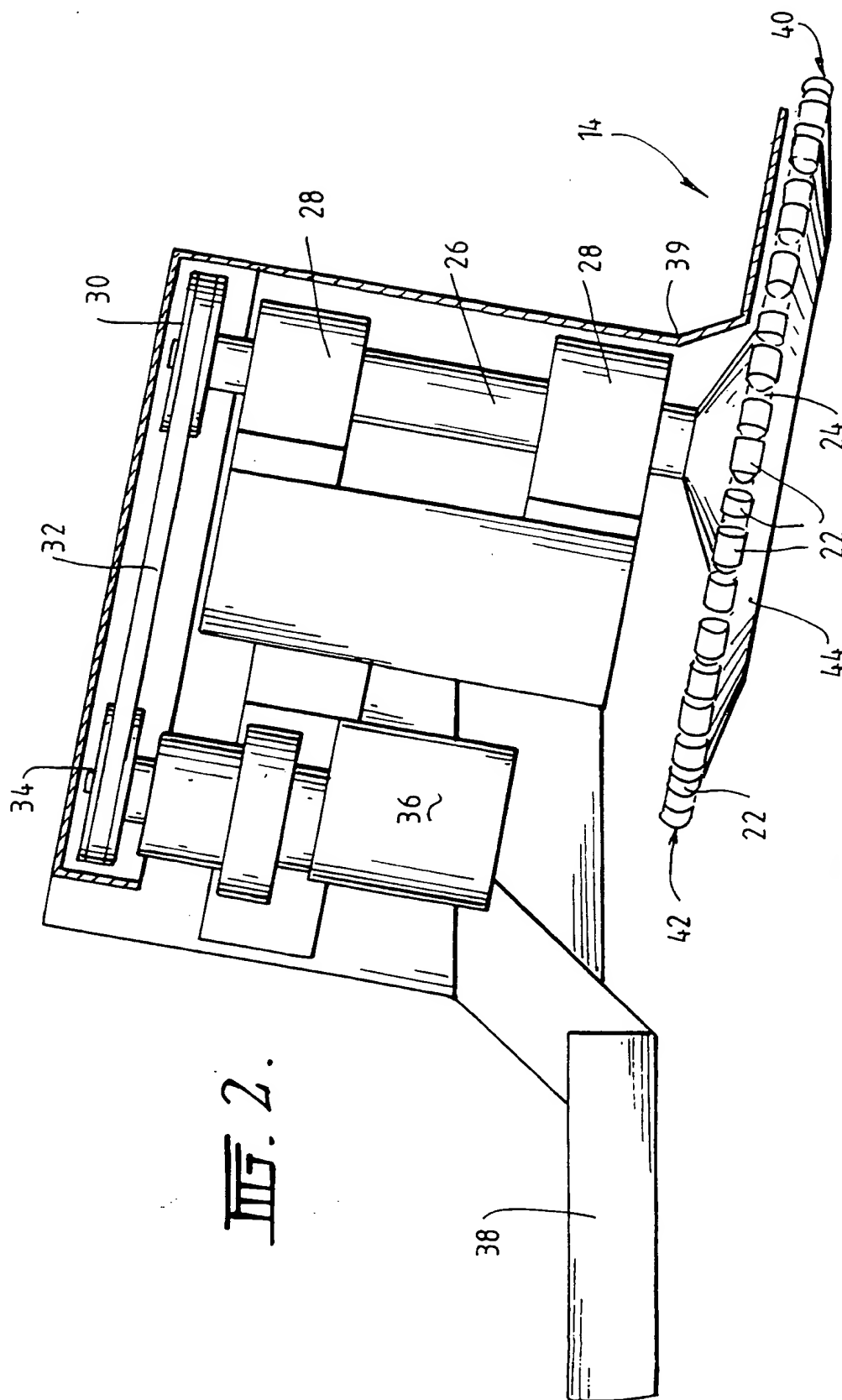
13. A tree harvesting apparatus according to claims 11 or 12 wherein the

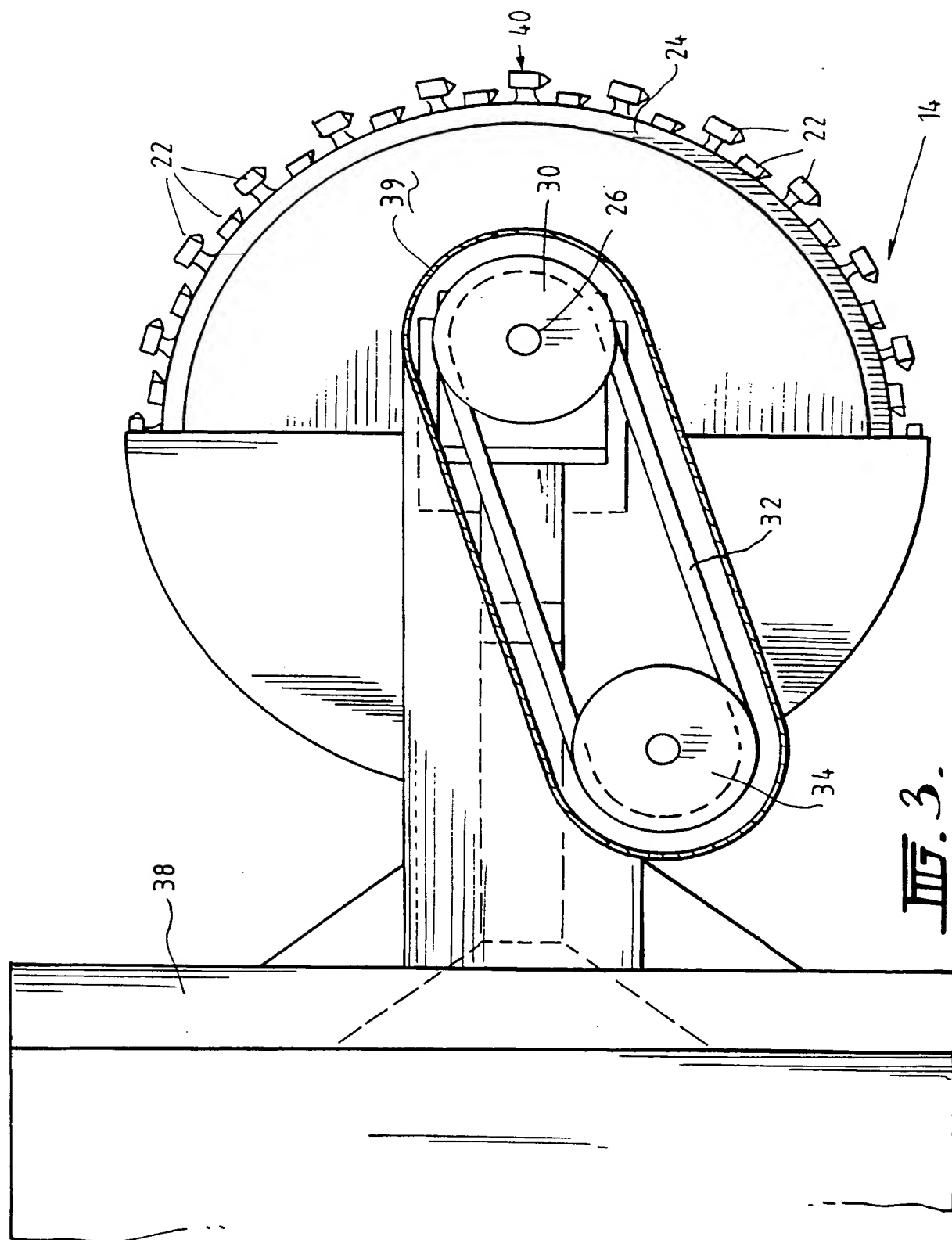
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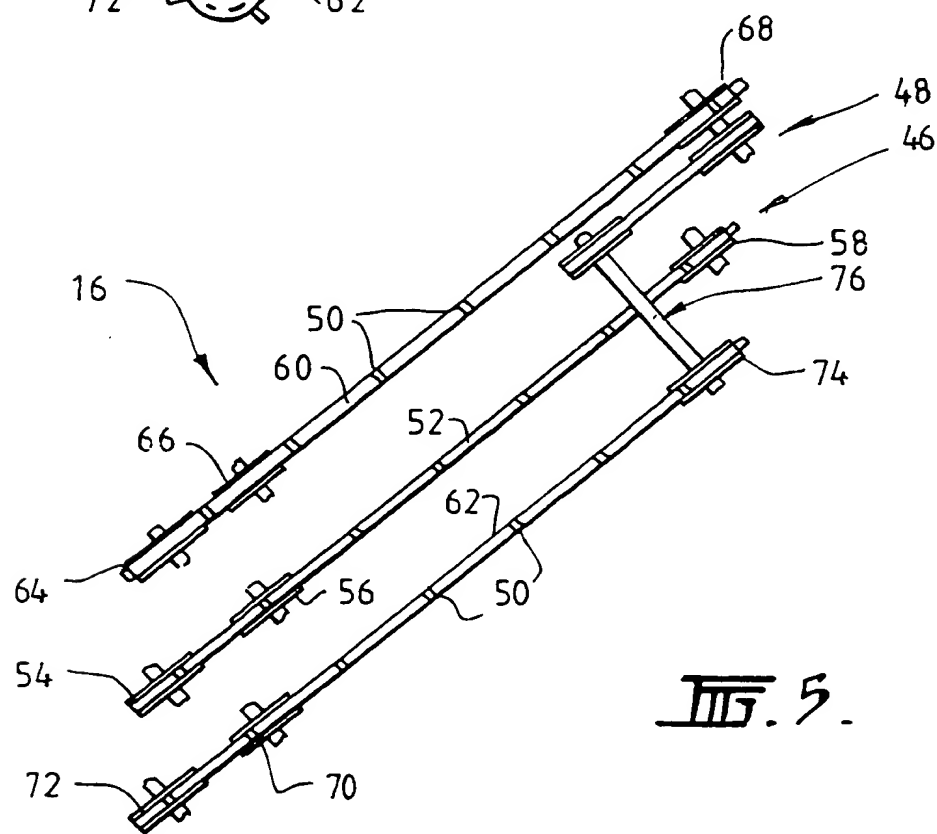
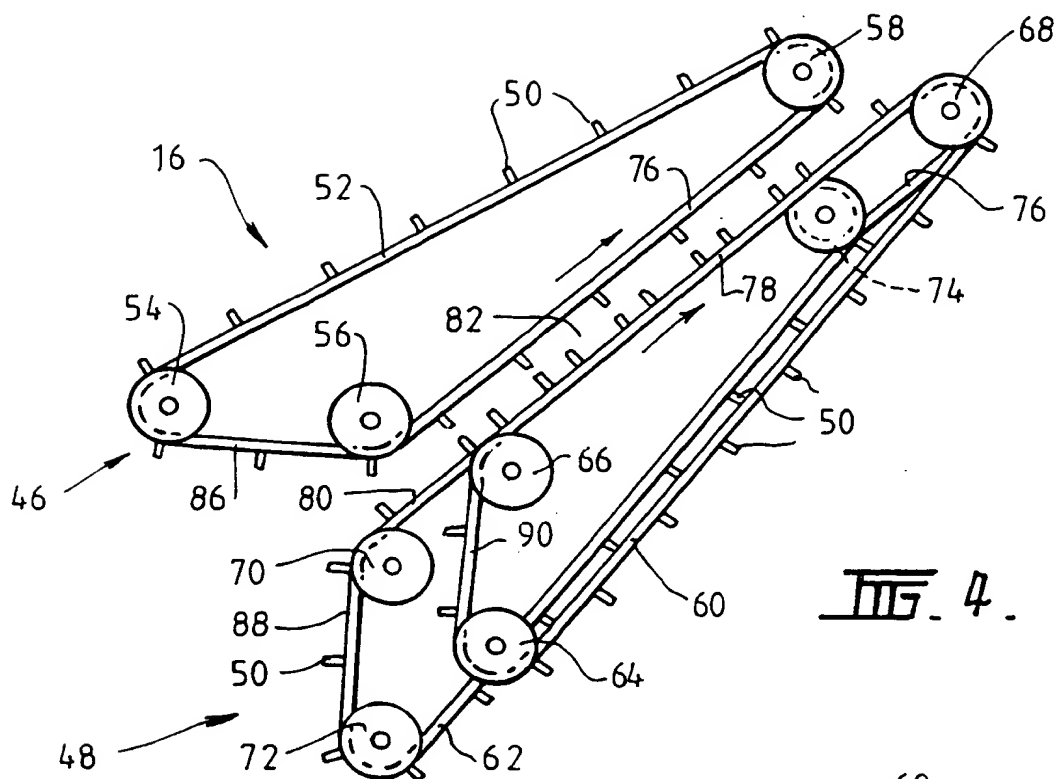
transport means includes a second pair of spaced apart rollers inclined upwardly from a lower end distant said the chipping means for gripping a trunk of the cut tree and advancing the cut tree to said chipping means.

- 5 14. A tree harvesting apparatus according to any one of claims 1-13 further including a pair of wheels located in advance of said transport means between which a crown of a tree passes prior to the tree being cut by the rotary saw, said wheels biased and pivotally mounted to work around and at least partially compress the crown of the tree.
- 10 15. A tree harvesting apparatus substantially as herein described with reference to and as illustrated in the accompanying drawings.









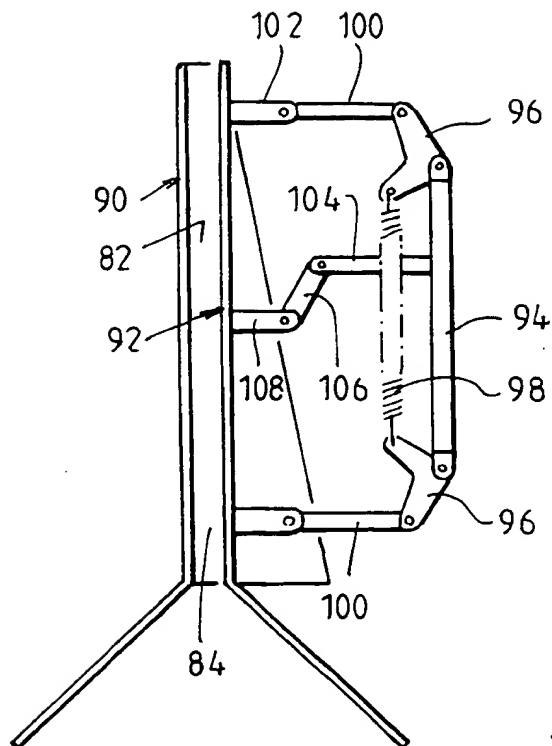


FIG. 6.

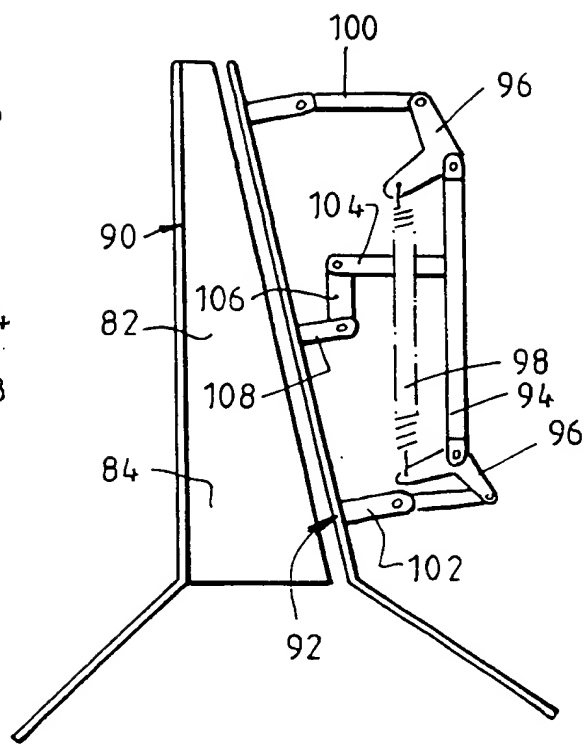


FIG. 7.

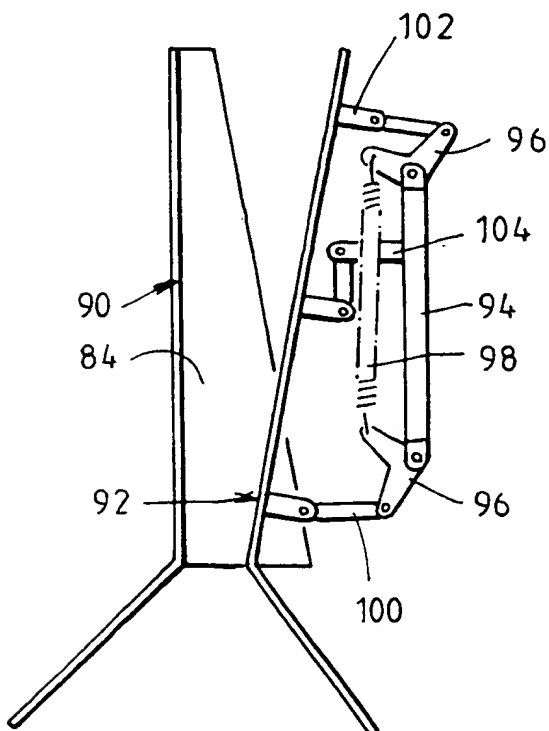


FIG. 8.

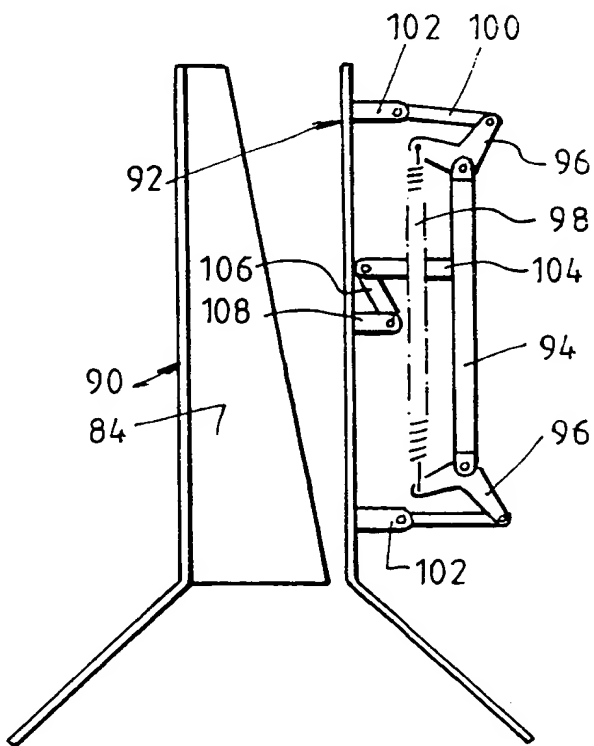
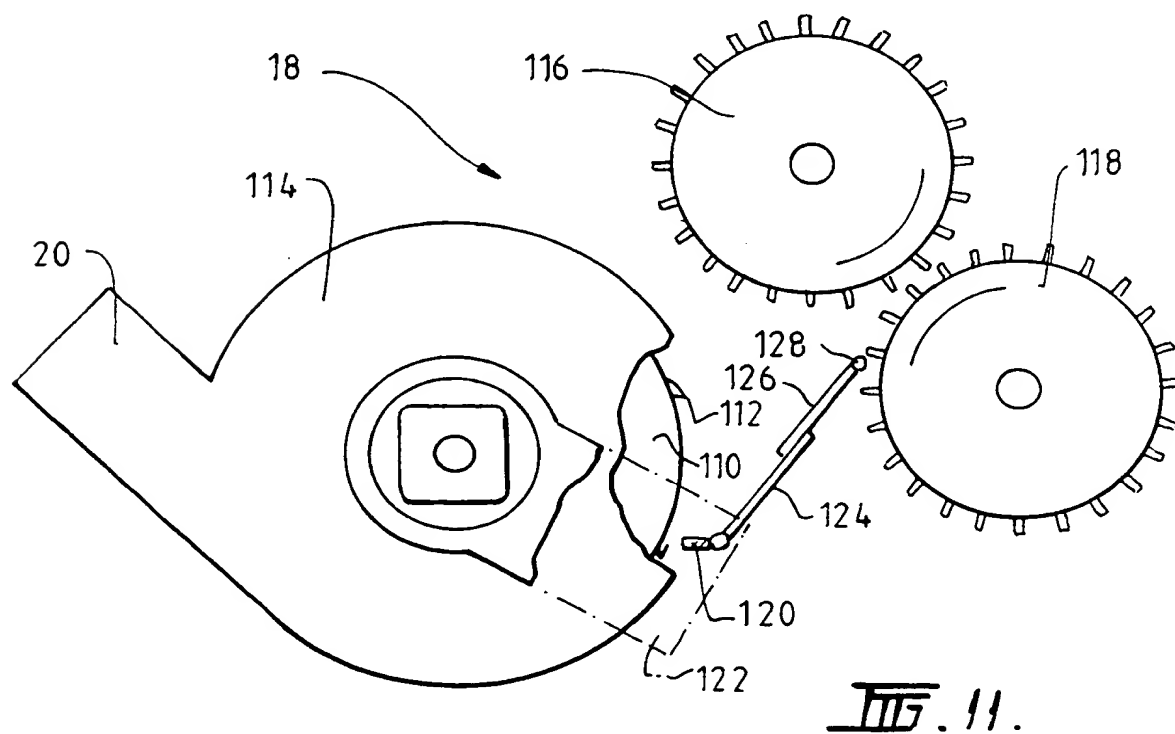
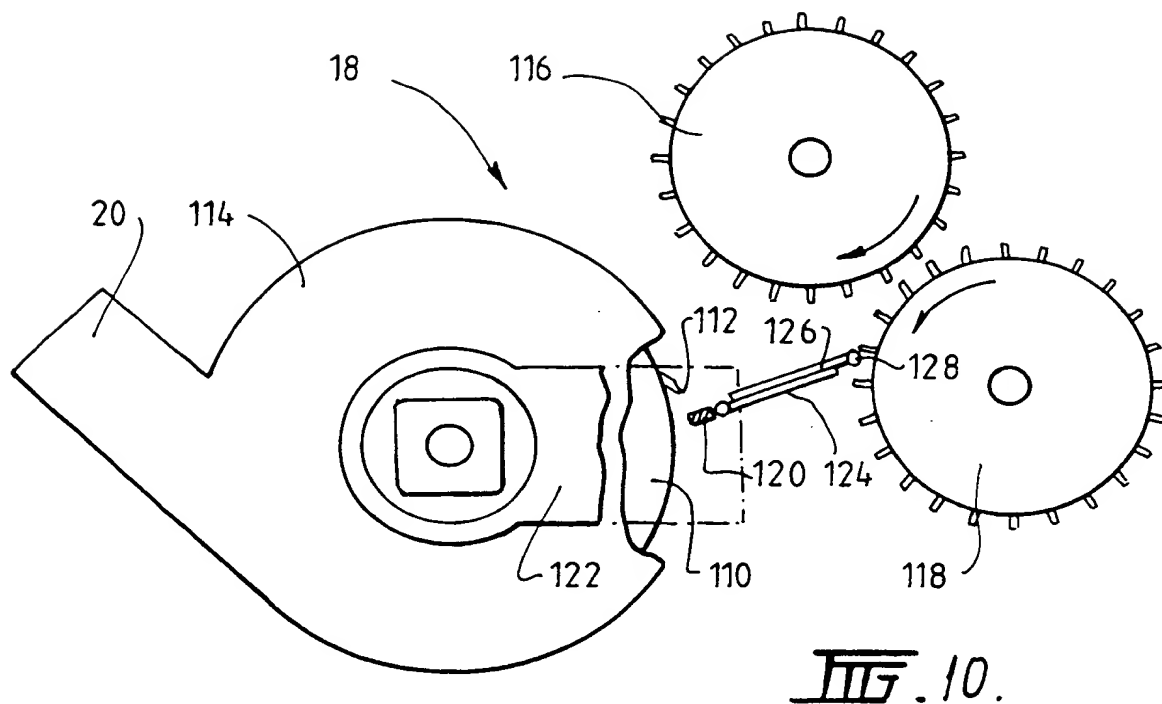
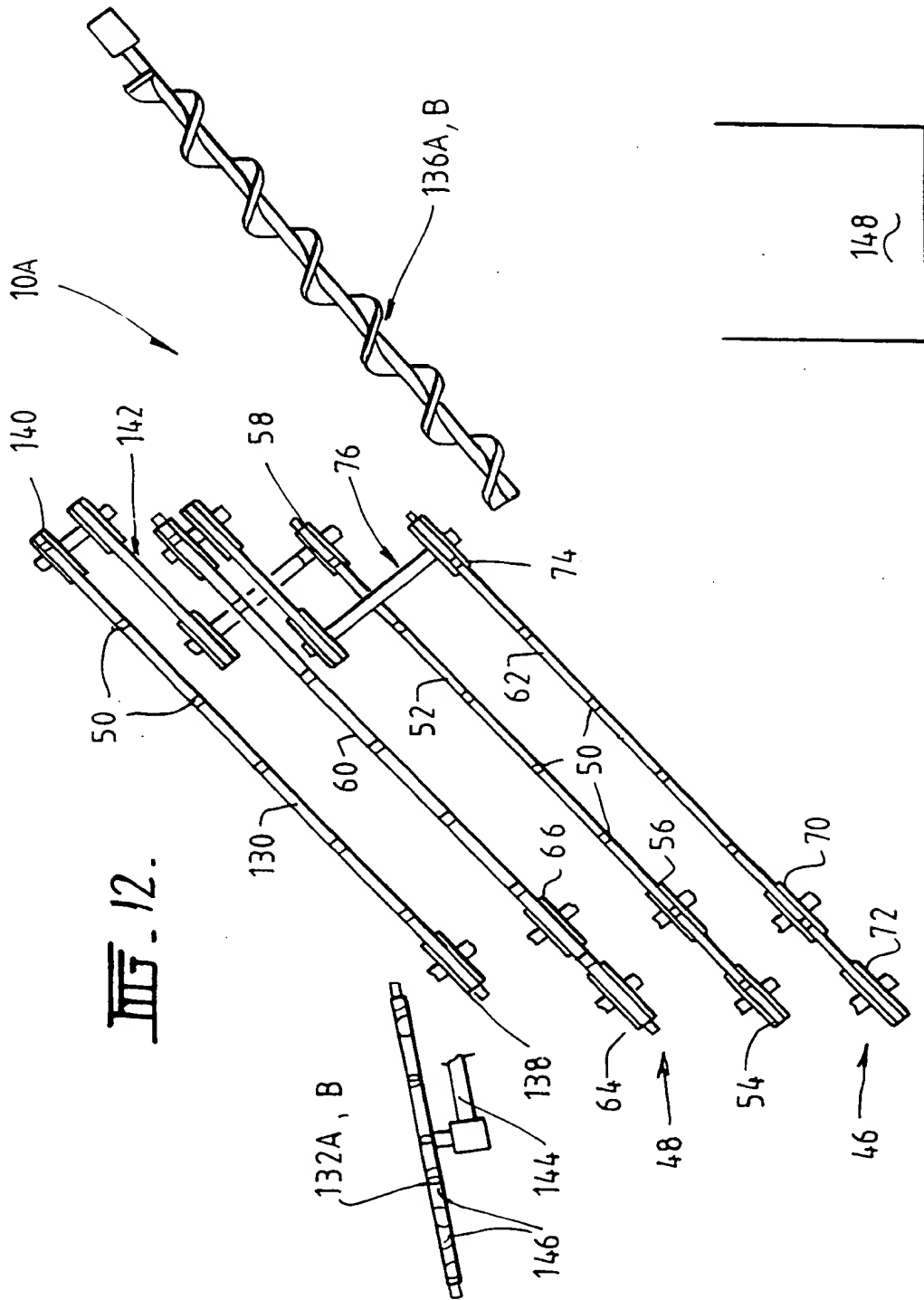
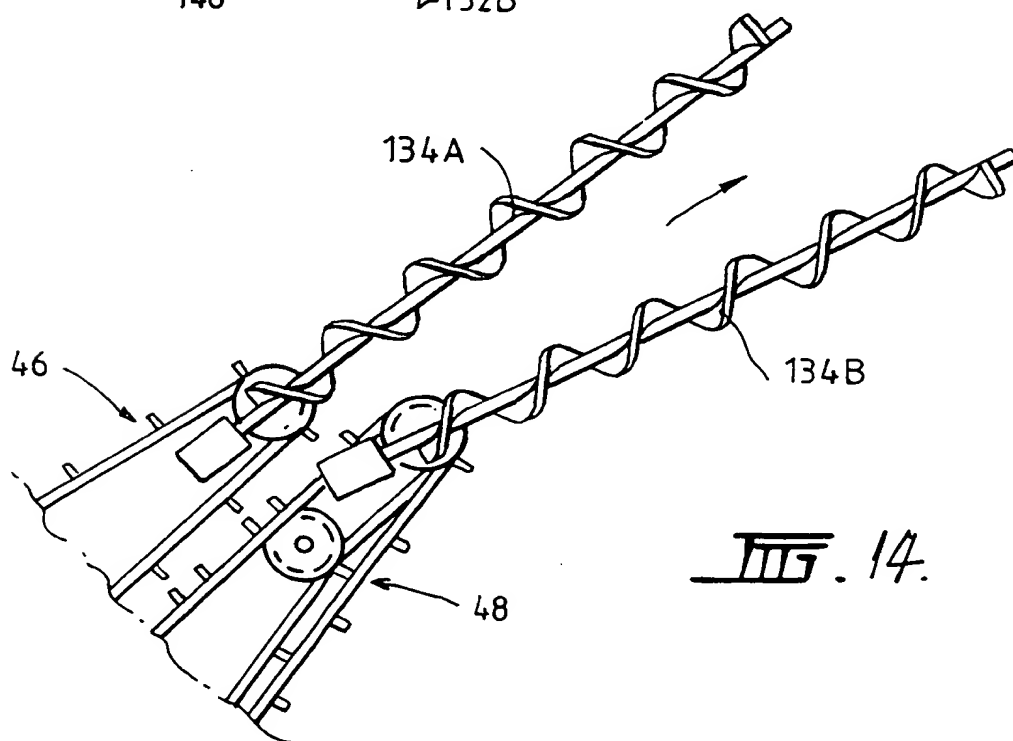
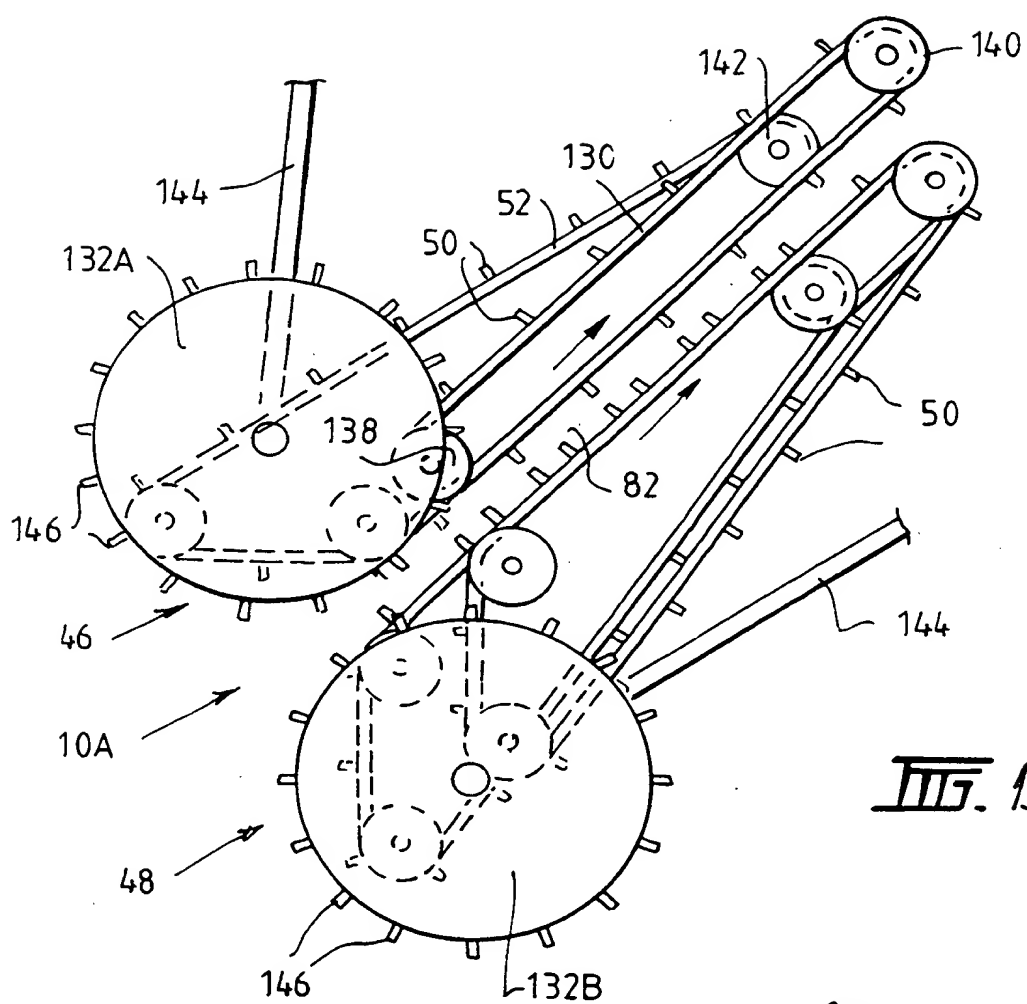


FIG. 9.







INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 00/00171

A. CLASSIFICATION OF SUBJECT MATTER																						
Int Cl ⁷ : AO1G 23/08, 23/093, B27L 11/00																						
According to International Patent Classification (IPC) or to both national classification and IPC																						
B. FIELDS SEARCHED																						
Minimum documentation searched (classification system followed by classification symbols) IPC AO1G 23/08, 23/093, B27L 11/00																						
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched AU : IPC as above																						
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) DWPI + keywords																						
C. DOCUMENTS CONSIDERED TO BE RELEVANT																						
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.																				
X	US 4 338 985 A (SMITH) 13 July 1982 whole document	1, 10																				
X	US 4 784 195 A (EGGEN) 15 November 1988 whole document	1																				
X	US 4 057 192 A (SMITH) 8 November 1977 whole document	1																				
<input type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex																						
<p>* Special categories of cited documents:</p> <table border="0"> <tr> <td>"A"</td> <td>Document defining the general state of the art which is not considered to be of particular relevance</td> <td>"T"</td> <td>later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</td> </tr> <tr> <td>"E"</td> <td>earlier application or patent but published on or after the international filing date</td> <td>"X"</td> <td>document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</td> </tr> <tr> <td>"L"</td> <td>document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</td> <td>"Y"</td> <td>document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</td> </tr> <tr> <td>"O"</td> <td>document referring to an oral disclosure, use, exhibition or other means</td> <td>"&"</td> <td>document member of the same patent family</td> </tr> <tr> <td>"P"</td> <td>document published prior to the international filing date but later than the priority date claimed</td> <td></td> <td></td> </tr> </table>			"A"	Document defining the general state of the art which is not considered to be of particular relevance	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	"E"	earlier application or patent but published on or after the international filing date	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	"O"	document referring to an oral disclosure, use, exhibition or other means	"&"	document member of the same patent family	"P"	document published prior to the international filing date but later than the priority date claimed		
"A"	Document defining the general state of the art which is not considered to be of particular relevance	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention																			
"E"	earlier application or patent but published on or after the international filing date	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone																			
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art																			
"O"	document referring to an oral disclosure, use, exhibition or other means	"&"	document member of the same patent family																			
"P"	document published prior to the international filing date but later than the priority date claimed																					
Date of the actual completion of the international search 31 March 2000		Date of mailing of the international search report 17 APR 2000																				
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200 WODEN ACT 2606 AUSTRALIA E-mail address: pct@ipaustalia.gov.au Facsimile No.: (02) 6285 3929		Authorized officer B. NGUYEN Telephone No.: (02) 6283 2306																				

International application No.
PCT/AU 00/00171

Patent Document Cited in Search Report		Patent Family Member	
US	4338985	BR	8006626
		CA	1163174
		CA	1176543
		CA	1178873
US	4784195	NONE	
US	4057192	NONE	

END OF ANNEX